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PSYCHE

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A NEW LESTODIPLOSIS

BY E. P. FELT,

Stamford, Conn.

A number of specimens were received from Mr. C. W. Collins, U. S. Bureau of Entomology laboratory, Melrose Highlands, Mass., and bearing the note number 9590c43, dated January 26, 1932, the record being by Mr. A. B. Proper. The following are the essentials of the original record. On July 11, 1931, an adult Dipteron issued from a pupa which had been formed in a vial in the Laboratory. The larva from which it came was reddish and of a sort commonly encountered while looking at spruce twigs. In this case, it was near or upon a dead larva of *Epinotia nanana,* which larva was saved and mounted upon the same slide as with the pupal case and the fly. It was not possible in many cases to tie up any host with this type of larva, which tends to throw doubt upon the authenticity of this apparent host relationship. The same type of Dipterous maggot has been encountered occasionally when making examinations for infestation of pine twigs by *Rhyacionia buoliana.*

The above record, in connection with the fact that Lestodiplosis larvae are known to be predaceous and have been reared rather commonly from galleries inhabited by Coleopterous borers, leads us to believe that this tentative association is correct and that the Lestodiplosis maggots were actually preying upon the Epinotia caterpillars and presumably prey upon those of Rhyacionia. The species approaches closely in general characteristics our *Lestodiplosis scrophulariæ*, though it appears to be distinct and is characterized below.

Lestodiplosis novangliæ n. sp.

Male. Length .9 mm. Antennae one-half longer than the body, thickly haired, fuscous; 14 segments, the fifth with stems having a length three and two and a half times their diameters respectively, the terminal segment with a stem six times its diameter, the distal enlargement with a length four times its diameter and rounded apically. Palpi quadriarticulate. Mesonotum dull reddish brown, sparsely haired. Scutellum yellowish, postscutellum reddish yellow. Abdomen reddish orange, fuscous basally. Wings hyaline. Halteres pale yellowish. Legs mostly pale straw, the distal tarsal segments a variable fuscous. Dorsal plate long, broad, deeply and triangularly emarginate, the lobes narrowly rounded. Ventral plate long, broad, and broadly rounded apically.

Female. Length 1 mm. Antennae nearly as long as the body, sparsely haired, light fuscous; 14 segments, the fifth with a stem as long as the enlargement, the latter with a length two and a half times its diameter, the terminal segment cylindrical, with a length two and a half times its diameter and broadly rounded apically. Mesonotum light brown. Scutellum yellowish, postscutellum darker. Abdomen pale yellowish, with the basal segments fuscous. Ovipositor short, the terminal lobes sparsely haired and with a length two and a half times the width. Other characters practically as in the male.

THE TROPISMS EFFECTING COPULATION IN THE BED BUG.

By Ezekiel Rivnay

The fact that the female of the bed bug has a special asymmetrical opening for the reception of the male copulatory organs, rather than the ordinary vagina, makes this study extremely interesting. It is astonishing that this fact escaped the attention of early investigators and that the copulatory organs of so well-known an insect were unknown until comparatively recent years. A complete and detailed description of copulation in bed bugs was published by Hase (1918), and the most complete study of the sexual organs and their functions was made by Cragg (1914, 1920 and 1925). Copulation of bed bugs was observed by the present writer during the course of rearing them in connection with other studies. The peculiarity in this act is that the male mounts the female obliquely in such a manner that his head falls over the left side of the pronotum of the female; his left legs grasp the posterior part of her abdominal margin; and his posterior abdominal segment is bent deeply so that the tip reaches the right side

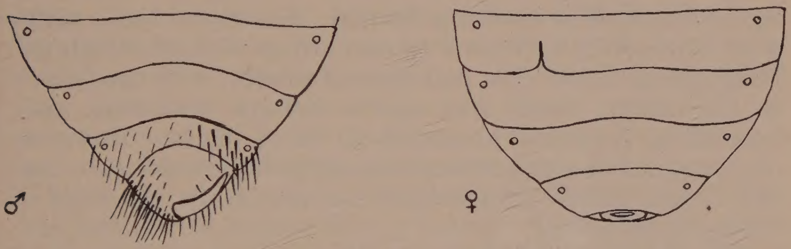

Fig. 1 Fig. 2

Ventral view of abdomen of the bed bug; Fig. 1, male; Fig. 2, female of the ventral segments of the female where the copulatory slit is located (Fig. 2). They remain in this position anywhere from one to several minutes.

No attempt was made by previous observers to establish the facts as to how the male locates the female, and what tropic reactions govern the act of copulation, which is so unique in this insect. In the following paragraphs, the results of a study are given wherein the writer attempts to discover some of the facts regarding this problem.

In some insects, chemotropic reactions are of extreme importance in bringing together the two sexes of the same species for mating purposes. Mayer (1900) demonstrated what attracting force the odor from the female of the *C. prometha* moth has upon the male. In the case of the Japanese beetle, the female apparently diffuses some odor which is attractive to the males. On several occasions, the writer observed in the field, early in the season, over twenty males clustered around one female. Several of these males were attempting to mate with each other, a phase which will be discussed later. The ball-formed cluster, with the female in the center, would lead one to believe that some odor emanating from her attracted all these males. However, observations and experiments described below indicate that the "smell mind" idea cannot be applied in the case of *Cimex lectularius*.

A female approached a male from the rear and remained in this vicinity for a long time, yet the male did not perceive her. Only when the female passed in front of the male did the latter take cognizance of her and soon made attempts to mate with her. Such observations occurred upon other occasions. If odor signals the presence of a female, its effects should be manifested regardless of the position of the female, as long as she is in the proximity of the male. This did not seem to be the case in the above-mentioned observations. In order to verify these casual observations, the following experiments were conducted.

Five females were placed in a vial, 2 cm. in diameter and a piece of cheese-cloth was spread and fastened over its opening. This was then turned upside down so that the cloth served as the foothold for the five bugs; it was then placed in a petri dish, allowing space for free circulation of air and odor. A similar vial, not containing bugs, was placed in the dish as a control. Five vigorous males were put in the dish and left there for 30 minutes. Although the males were in close proximity of the females, they did not pay any attention to them but contrarily made attempts to mate with each other. This experiment was repeated several times with similar results. If there is a secretion, the odor of which serves to entice the male, one would expect this odor to be characteristic of the female only. As a result, one would presuppose that a few males, if brought near females, would cluster around them or around their container in the attempt to mate with them. This was not the case in the experiments.

Again, three males were placed in a petri dish. Not long after, one female was placed together with them. All remained inactive because the room temperature was rather low. Upon increasing the temperature slightly, the bugs became more active. One male soon mated with the female, while the other male attempted to copulate with the third one. Contrary to expectation, the three males did not crowd around the single female as would have been the case had the female radiated some attractive odor.

From the observations mentioned previously, the writer was inclined to believe that it is more likely that the sight of the moving image guides the male to the female rather than the odor. The following experiments were carried out to discover whether such was the case.

A dead female was placed at the rear of a male and was left there for two or three minutes. The male did not observe her. The dead female was then placed about 15 mm. in front of the male and left there for three or four minutes. Here, also, the male did not notice her. The female was then moved slowly with the aid of a fine camel's hair brush, imitating the crawling of a live bug. The male, which had remained inert all this time "woke up," extended his antennae in the direction of the dead female, and suddenly jumped upon her and made every effort to mate with her. Similar procedures were carried out several times and also at other occasions with different males, and very often similar results were obtained. On one occasion, the two were tipped over so that the writer could observe, under the microscope, the protruded genitalia, attempting to open the copulatory slit situated between the fourth and fifth abdominal sternites of the dead female.

The question will arise as to whether the dead female bed bug had some odor emanating from her which stimulated the male. It might, also, be suggested that the odor of the glandular secretion, if there is such, may be preserved in the female a long time after she is dead. Attempting to clarify this matter, one female was chosen which had been preserved in 70% alcohol for sixteen weeks. After she had been blotted and dried, she was placed in front of the male and was then moved slowly with the brush, imitating the crawling of the live bug. The male reacted to this dead female in the same manner as described heretofore. However, a still better proof that the sight of the crawling female, rather than the odor emanating from her, brings the male to her, may be derived from the following experiment.

A piece of cork was carved out into the size and approximate shape of a bed bug. After it was painted with ink and dried, it was placed in front of a male and moved slowly with the brush, again imitating the crawling of a bug. The male suddenly jumped upon it in the same manner as if it were a live female bed bug, but soon dismounted. A few other males reacted in like manner.

It is clear, therefore, that not the odor, but the sight of a moving female, awakens in the male when he is under proper physiologic conditions, the desire to come in direct contact with her. It is also a noteworthy fact that the males lack the faculty of distinguishing between the two sexes, or even a lifeless object of the same size and shape. Recognition of the female occurs through the sense of touch when the male is in direct contact with her. It is then that the male orients himself in a different manner with reference to the surface of the body of the female.

Such reactions were observed by the writer in some beetles. In the potato beetle, *L. 10-lineata*, the male is of the same hemispherical shape as the female; consequently males attempt, often, to copulate with others of their own sex. They even fail to differentiate between mature larvae and adults which are of approximate size and shape. The identical shape of the two sexes in the Japanese beetle, *P. japonica*, was also the reason for similar behavior in the case described above. The odor may have guided the males to the female; however, upon coming in close contact with each other, they failed to discriminate between the two sexes. The male of the lady beetle, *C. 9-punctata*, previous to the act of mating, places the forelegs over the middle of the hemispherical body of the female and pivots over her, touching with his posterior legs and the tips of his ventrum the margins of the female. One observer relates how a male of the Scarabaeid species, *Dynastes tityus* L., having been permitted to crawl over his fingers, upon reaching the thumb, oriented himself upon the nail and attempted to insert his genitalia in the space between the nail and skin. One who is familiar with the size and shape of this beetle, and the similarity of the same to a thumb nail, will understand the cause of such a reaction.

Reactions of such a nature were designated by early observers as "stereotropic"—meaning reactions to solid objects. This term, the writer believes, is not specific and he suggests the term "morphotaxis" for the particular kind of reaction discussed previously. This term is more suitable because it is the particular shape of the surface of the female or her specific form which calls forth the definite orientation. Morphotaxis may be considered as a more specific division of stereotaxis. The general term "thigmotaxis," substituting "stereotaxis," the writer believes, is entirely inappropriate for this reason: Most, and perhaps all of the technical names of the various tropisms are based on the Greek name of the stimulus which causes the reaction and not on the name of the sense by which the stimulus is perceived. Thus the terms are "phototaxis" or "chemotaxis" and not "optiotaxis" or "olfactotaxis." Hence, why should "thigmotaxis"—orientation according to touch—substitute "stereotaxis"—reaction to solid objects?

In the case with the above-mentioned Coleoptera, although the males manifested definite orientations with respect to the characteristic shape of their own species, they lacked the faculty to "recognize" the female even after they came in direct contact with the other individual. The bed bug in this respect is more sensitive. It is true, by the sense of sight it does not distinguish a dead object from a live individual, but, upon coming in contact with it, it immediately recognizes the female. As mentioned above, the piece of cork was mounted and dismounted very quickly. The crude carving could not produce the natural shape of the bed bug and the male recognized the imitation very readily. When a male mounts another male, the lower one usually bends the tip of his abdomen upward; he thereby causes a change in his normal shape and form which, in turn, causes the upper male to dismount. Otherwise, the latter orients himself in the characteristic fashion as if he were a female. The shape of the latter stimulates the male to orient himself obliquely as described in the foregoing, rather than laterally. The sense organs of touch along the ventral sides of the last abdominal segments of the male are unequally distributed (Text figure 1). It seems that the shape of the female in this position is so stimulating that even a dead individual calls forth the final copulatory reactions.

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THE PERICOPID GENUS *COMPOSIA* (*Lepidoptera*)

BY MARSTON BATES,
Museum of Comparative Zoology, Cambridge, Mass.

Genus COMPOSIA Hübner

Hübner, Ver. bek. Schm., p. 179 (1822). Genotype, *Bombyx credula* Fabricius, sole species.

Forbes (1930) has reviewed the two previously known forms of the genus, giving some bibliography that has not been repeated here.

Key to forms.

1. Hindwing with two rows of white spots on the disc, in addition to the submarginal row .... 2.
   Hindwing immaculate except for the submarginal row of white spots .... 3.
2. Base of costa of forewing above with three white spots, which do not extend below the radial vein.... 1. *C. credula.*
   Base of costa of forewing with a red triangular area, which reaches the cubital stem below...... 2. *C. utowana.*
3. Costa of forewing above with three distinct red spots, limited as in *credula*........ 3a. *C. f. fidelissima.*
   These spots usually in part confluent, the outer spot extending below the radial vein, across the cell. .... 3b. *C. f. vagrans.*

1. **Composia credula** (Fabricius)

Bombyx credula Fabricius, 1775, p. 584; *id.*, 1793, p. 475.
[*Phalaena*] *sybaris* Cramer, Pap. Ex., I, p. 112, pl. 71, fig. E. (1775).
Composia credula Hübner, Verz. bek. Schm., p. 179 (1822); *id.*, Samml. ex. Schm., II, pl. 188, 4 figs. (1819-1826).
Composia sybaris Forbes, 1930, p. 40.

There are eight specimens of this species in the Museum of Comparative Zoology from Hispaniola and Jamaica; they show no racial differences. Puerto Rican specimens are said to agree with these also.

2. **Composia utowana**, n. sp.

The front is black, with white lateral stripes; the palpus is black and white: the third joint proportionately smaller than in *credula* or *fidelissima*. The thorax is black with three transverse rows of small spots above: the first two rows yellow, the last white, in the male, only the first row yellow in the female; beneath, the white is more extensive. The legs are marked much as in *fidelissima*. The abdomen is blue, the anterior edge of each segment marked with white, which forms a complete transverse band, except for a narrow mid-dorsal interruption.

The wings are black, with most of the hindwing, and the base and a small area at the tip of the cell of the forewing, irridescent blue. A red patch on the forewing covers the base of the cell and the lower half of the costa; three rows of white spots on this wing are similar in number and position to the spots on *fidelissima*, but much larger, and there are three additional spots in the median area never found in that species. The three rows of white spots on the hindwing are arranged as in *credula*, but are larger and more irregular. The pattern of the upper surface is repeated below.

Holotype (♂), and allotype (♀), No. 16594, in the Museum of Comparative Zoology, from Mariguana Island, Bahamas, Feb. 25, 1933, T. Barbour and David Fairchild.

This lovely moth is named after Allison V. Armour's yacht, the Utowana: the means through which our knowledge of tropical island life in both hemispheres has been greatly enlarged.

3a. **Composia fidelissima fidelissima** H. S.

Composia fidelissima Herrich-Schäffer, 1866, p. 132; Gundlach, 1881, p. 250; Forbes, 1930, p. 41.
Phaloësia olympia Butler, 1871, p. 290.

The seven specimens of this form in the M. C. Z. show a very constant wing pattern. They come from Habana and Cienfuegos, in Cuba. I have seen no Central or South American specimens, but a specimen from Swan Island agrees closely with those from Cuba.

3b. **Composia fidelissima vagrans,** n. subsp.

Composia fidelissima Dyar, 1890, p. 105.
Composia olympia French, 1890, p. 153.

Bahaman specimens of this species differ strikingly from Cuban individuals in the character of the red markings on the costa of the forewing. The two basal spots are usually confluent, and the outer spot is much elongated, with a branch directed posteriorly across the cell. In New Providence specimens, this cell mark is a broad band; in specimens from Andros Is., Berry Is. and Crooked Is., it is much narrowed, and in Watling specimens it becomes white, near the cubital vein at least. Florida specimens show all of these variations, and some even approach the typical Cuban race very closely, having no spur across the radial vein at all on the upper surface; below, however, a red spur reaches the cubital vein in all of the specimens before me.

Holotype (♂) and allotype (♀) No. 16595 in the M. C. Z., from Nassau, New Providence, Dec. 31, 1931, Allison V. Armour Expedition. There are 12 paratypes from New Providence, Andros, Berry, Crooked and Watling Islands, dated Feb., Apr. and July. There are also 11 Florida specimens, which belong to this race, from Lake Worth, Key West, Coconut Grove and Miami, dated Mar., Nov. and Dec.

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CONDITIONED BEHAVIOR AMONG TERMITES (ISOPTERA)

By Alfred E. Emerson

University of Chicago

At the present time, no adequate observation indicating that the behavior of termites may be conditioned has been recorded. In several instances, so-called "intelligent" behavior of termites has been described or assumed (Bugnion, 1927; Hingston, 1929, 1932), but in none of these cases is it clearly shown that a termite behaves differently in the same situation before and after an experience. In as much as conditioned responses have been adequately demonstrated in various insects including ants, bees and cockroaches, it seems entirely possible that termites also are capable of learning, but experiments with rigid control have not been performed on termites with positive results. Julius F. Bosen has performed preliminary experiments with a simple maze similar to that used successfully by Gates and Allee (1933) for cockroaches. No indication of conditioning was detected, possibly owing to the fact that blind worker termites were used. The reward was a relatively moist chamber to which the termites reacted positively.

The following observations were made three years ago on a captive colony of *Reticulitermes arenincola* Goellner collected at Miller, Indiana, in the Lake Michigan sand dunes. Publication was delayed in the hope that further observations and experiments might bring more data to bear upon the problem, but this hope has not materialized.

The captive colony, containing many workers, several soldiers, several nymphs, two mature second form queens and one mature third form queen resided in apparent harmony in a glass dish with a ground glass cover for a month.

On August 15, 1930, one of the second form queens and the third form queen were noticed jerking themselves violently and exhibiting great agitation. When they came in contact with each other they fought vigorously. Upon separating they remained excited, jerking themselves in the manner characteristic of all disturbed termites. Workers often attempted to lick these queens, at no time showing hostility to them during the conflict. The other second form queen was not involved in the fight in any way. The fighting queens continued the combat whenever they came into chance contact after intervals of separation, each seeming to be equally belligerent. During a half hour they fought and separated ten times. In the final encounter, the second form queen lost a leg and the third form queen was seriously bitten on the under side of the head. After a short time, the queens separated and the workers and nymphs immediately attacked the third form queen, biting and chewing it for a half hour until it was quite weak. The workers also attempted to bite the injured leg stump of the second form queen, but she managed to protect herself from serious injury by violently jerking. Other workers, busy with nest repair work in close vicinity to the injured queens, were not observed paying any attention to these events.

The termite workers and winged nymphs attacking the third form queen bit holes in her abdomen and head and seemed to give as much attention to all parts of her as they did to the injured parts. At any given moment seven or eight workers were eating this queen. The second form queen was licked and massaged by the workers and after about a half hour, the injured leg received no special notice.

The fight was first observed at about 12 noon. At 2 P. M. the third form queen had been decapitated and two separate groups of termites were eating the head and body. The second form queen at this time was quiet and several workers were licking her with no manifest hostile actions. At 3 P. M. the third form queen had been entirely eaten and the second form queen was quiet and in good condition. Six days later this second form queen was still alive and evidently healthy. The other second form queen which had taken no part in the fight was also still alive and well.

This observation does not readily fit into the class of inherited instinctive behavior. If either or both queens had had any characteristic which would stimulate general hostile action, one would assume that the workers and soldiers would have shown hostility and possibly the third queen would also have been involved in the fight. General hostile action toward a strange termite or other insect often has been observed, but in such cases any termite coming into contact with the stranger will attack it. These two queens, however, showed hostility only to each other (indicating an interesting ability to recognize each other) and no other termites exhibited hostility to either of them until they were badly injured, when the cannibalistic activities well known in termite colonies appeared. The observation is interesting as an example of naturally induced cannibalism.

The presence of the third queen gives a fairly good control against the possibility that this antagonistic behavior between the queens was a caste pattern. The fact that all three of the queens lived together in harmony before the fight occurred also offers a fair control against the possibility that this hostile action was induced through hereditary caste differences. Field observations summarized in table I indicate no evidence of common antagonism between the different reproductive castes or individuals, which are often found living together harmoniously in the same nest.

Possibly one might explain such action as inherited individual differences occurring at a certain stage in the life cycle. It is also possible that the antagonistic behavior was in some way induced by an internal physiological influence not present at the same time in the third queen.

Although it must be admitted that these interpretations are possible, it seems to the writer that the mutual hostility displayed by these queens is best explained on the basis of a conditioned response. The nature of the experience which may have conditioned these queens to such individualistic action, however, remains unknown.

TABLE I

Records of reproductive castes found living together in the same nest. Numbers refer to the number of each caste collected.

	1st form king	1st form queen	2d form king	2d form queen	3d form queen
Reticulitermes flavipes (Kollar). Cold Spring Harbor, N. Y.	—	—	113	126	—
Reticulitermes flavipes (Kollar). See Banks and Snyder (1920)	1	—	—	X	—
Reticulitermes arenincola Goellner Miller, Indiana	—	—	—	2	1
Rhinotermes (R.) *tenebrosus* Emerson Kartabo, Br. Guiana	—	—	—	1	1
Armitermes (A.) *albidus* (Hagen) Kartabo, Br. Guiana	—	1	1	2	—
Armitermes (A.) *percutiens* Emerson Kartabo, Br. Guiana	—	—	2	78	—
Armitermes (A.) *percutiens* Emerson Kartabo, Br. Guiana	1	—	—	7	—
Armitermes (A.) *minutus* Emerson Kartabo, Br. Guiana	1	—	—	35	—
Nasutitermes (N.) *costalis* (Holmgren) Grenada, West Indies	30	46	—	—	—
Nasutitermes (*Subulitermes*) *parvellus* (Silvestri) Kartabo, Br. Guiana	1	—	—	5	—

SUMMARY

No valid case of a conditioned response in termites has been reported. The behavior described in the literature can readily be interpreted as the result of hereditary influences and thus may be referred to as instinctive. A fight between two queens in a captive colony in the presence of workers, nymphs, soldiers and another queen, none of which exhibited any antagonistic response to either of the

fighting queens, may be interpreted as a conditioned response leading to individualistic action.

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CICADAS IN TEXAS

East central Texas is a veritable cicada paradise. I have never visited a region where so many species are as abundant as occur in, for instance, the Madison County region. They are numerous in many parts of the post oak woods, but are most plentiful in the alluvial forests and groves in the lower grounds along the Navasota and Trinity Rivers. Here in June and July, the air is vibrant with the songs of *Tibicen superba, T. pruinosa, T. resh, T. marginalis, T. chloromera, T. lyricen and Diceroprocta vitripennis.* The chorus becomes most intense late in the afternoon, when *pruinosa* may predominate. The songs of the species mentioned differ considerably and are quite easily recognizable. *Tibicen resh* is often found in great numbers in some large detached oak or other tree standing in the open, the trunk of which may bear scores of the cast skins of this species. *Resh* may be silent for long intervals, when suddenly the whole population may burst into song simultaneously, resulting in an ear-splitting din which subsides as suddenly as it arose. The great cicada-killing wasp (*Sphecius speciosus*) is a constant attendant of the cicada aggregations, its deep hum being audible among the branches where an occasional agonized shriek of an unfortunate victim reveals the success of the wasp's hunting. These wasps vary greatly in size, and I have seen the smaller individuals (25-35 mm. in length) capturing the smaller cicadas as *Diceroprocta vitripennis.* Undoubtedly the larger individuals (40-50 mm. in length) select the larger species as *resh* or *marginalis.* Lurking in openings in the forests may be seen individuals of the robber-fly, *Microstylum morosum,* the largest American Asilid, sometimes reaching a length of 50 mm. This species frequently pounces on cicadas, carrying them off in its long legs to a bush or branch. Here the fly, suspended from the twig by a front leg and pressing the cicada to its long sharp beak with the others, feeds on its victim. I have seen this fly seize *D. vitripennis,* and Mr. F. F. Bibby and Mr. W. C. O'Dowd once took a large *T. resh* which had been captured by this *Microstylum.*

STANLEY W. BROMLEY.

A MIGRATORY FLIGHT OF *CATOPSILIA EUBULE* (LEPID.: PIERIDÆ).

By Harold O'Byrne

Webster Groves, Missouri

The butterflies belonging to the genus *Catopsilia* are frequent migrants, and many records of their migratory flights have been published. But these records are often vague as to the identity of the species, or they lack the precise data necessary to explain the problems that arise in connection with migratory behavior.

During September and early October of 1932, the writer has had an opportunity to witness a migratory flight of *Catopsilia eubule* L. which was in progress over a large part of St. Louis County, Missouri. Most of the observations were made at Webster Groves, but the flight was also seen in various other places. It was first noticed on September 3rd, and had probably already been going on for some time. The butterflies were flying almost due south (their direction being only a few degrees to the east) during the hours when butterflies are usually active, and on days when weather conditions were favorable to butterfly activity. On cool or cloudy days, as well as during the early morning hours, few or none were to be seen. They were most numerous between 10 A. M. and 3 P. M. The direction of the wind did not influence their flight. This was always in a southward direction although the prevailing winds were from the west and northwest. They flew from two to ten feet from the ground with an average of about five or six feet. Both sexes were observed in the movement.

Mr. Stuart L. O'Byrne, brother of the writer, made counts to determine the frequency with which the butterflies passed between him and a point approximately 100 feet east of his position, and the results are shown in the accompanying table. As already stated, all the butterflies flew southward, with only one lone individual flying in any other direction; this one changed its course from south to west, and disappeared in that direction.

FREQUENCY ON 100-FOOT FRONT

Date 1932	Time (Central Standard)	Elapsed time	No.	Average rate per hour	Wind	Weather
Sept. 3	1:08-1:20 P. M.	12 min.	21	105	Northwest	Part cloudy
Sept. 3	1:20-1:30 P. M.	10 min.	20	120	Northwest	Part cloudy
Sept. 3	3:24-3:36 P. M.	12 min.	18	90	West	Clear
Sept. 4	11:17-11:32 A. M.	15 min.	62	248	Variable; light breeze	Clear
Sept. 4	1:19-1:30 P. M.	11 min.	32	176	None	Part cloudy
Sept. 4	1:30-1:39 P. M.	9 min.	29	194	None	Part cloudy
Sept. 4	2:39-3:00 P. M.	21 min.	25	72	Variable; light	Part cloudy
Sept. 13	12:59-1:15 P. M.	16 min.	53	199	East-northeast	Part cloudy

Total time, 106 minutes; 260 butterflies counted; average rate, 147 per hour. All observations made at Webster Groves, Missouri.

It is interesting to note that the butterflies kept at a uniform height above ground, adapting their up and down flight to the knolls and depressions of the ground. The direction was not altered by encountering obstacles such as knolls or buildings; but the butterflies flew over them instead of around them. Upon reaching a railroad embankment, they flew downward, maintaining their usual distance from the ground, until they were just above the tracks; then, as they approached the shadow of a nearby viaduct, they turned upward and flew over the bridge, when they could have flown under it much more easily.

Their flight differed from the usual mode of this species in being a little less rapid, and not so erratic. They frequently stopped at flowers, sipping the nectar from one or more of the blossoms. Their stops were short; they seemed impatient to resume their march, and showed a restlessness that indicated a desire to press onward. There was no pairing, and they showed no flocking tendency; each individual was flying independently. Other species common hereabouts during this migration included *Colias eurytheme* Bdv., *Zerene caesonia* Stoll, and *Junonia coenia* Hbn., but they showed no disposition to join *eubule* in its southward flight.

Discussing the migration of butterflies, Clark ('32) suggests that the aggregation of male pierids about puddles of water is evidence of overcrowding, such assemblages being composed of the weaker individuals that have been unable to secure food because of competition and persecution by their more vigorous fellows; they therefore gather on muddy areas to obtain water. They subsequently begin to wander, and this leads to the formation of large migrating swarms which are almost wholly composed of males. They usually fly against the wind. He considers the migrations of *C. eubule* to be of this type, and that they therefore represent the end of the natural process of the elimination of surplus males. This explanation does not fit the facts in the present instance. During 1932 very few assemblages of pierids in muddy spots were seen in the region where the flight took place, although they were exceedingly numerous in 1931. This suggests that the heat and drought of 1931 brought them together at wet places, and that overcrowding had little to do with this phenomenon. Furthermore, these aggregations consisted mostly of *Eurema lisa* Bdv. & LeC., with some *Colias*, but only one or two *eubule* were ever seen in any one such group. In the migration observed in 1932, many females were seen. There was no tendency to fly against the wind; on the contrary, their flight was independent of wind direction.

There is good reason to believe that migration southward is an annual event in the life of this species in many parts of the United States. Scudder ('99) refers to it as a frequent migrant in the eastern states, and Brower ('30) says that in the neighborhood of Willard, Missouri, it "migrates through August, September, and October, coming from the northwest." Williams ('30-a) has collected many records of migration in the genus *Catopsilia;* many of these refer to *C. florella* Fab. in South Africa, and *C. eubule* and *C. statira* Cram. in tropical America. Most of the published records of "Catopsilia sp." or of "yellow butterflies" probably belong to these three species. In another paper Williams ('30-b) gives the results of counts made to determine the frequency with which butterflies in migration passed a given point. Observations of this kind on *C. florella* show that its migrations are indeed similar to the one observed by the writer in *C. eubule*. The large number of migration records in this genus are evidence of the frequency of its occurrence, and indicate that such behavior is no small factor in the biology of its species.

There is no evidence that a return flight takes place in *eubule*. The repopulating of the northern part of its range may be accomplished by a gradual dispersal northward during the summer, or through the increase in numbers of the few that manage to survive the winter. Of interest in this connection are the many records of individual northern occurrences of various southern species of this genus; for some recent records, reference is made to Calkins ('32), on *C. philea* L., *agarithe* Bdv. and *statira* in western Kansas, and citations by O'Byrne ('32) of some northern occurrences of *C. philea*. Such records refer to them as "strays," and indicate a possible way in which a northward spread of *eubule* could take place without attracting attention.

The foregoing data on *C. eubule* have important bearing on the nature of migration in insects. The question, whether insect migration is purposive, or is merely the result of their being blown about by the wind, is answered by the fact that the butterflies continued their flight day after day in the same direction, despite changes in the direction of the wind, and regardless of the contour of the ground and presence of obstacles. This has been fully discussed by Williams ('26), but the question still keeps bobbing up. The fact that the manner and speed of flight differed somewhat from the usual behavior indicates that the butterflies were in an abnormal physiological or mental state. The results of dissections of migrating females of *C. florella* by Williams ('30-a) give further weight to this suggestion, for they indicate that flight starts during a condition of sexual immaturity, and ceases when oviposition is ready to begin. It may be that the climatic changes of a temperate autumn are accompanied by internal changes in the butterflies. This is reasonable in view of the fact that the genus *Catopsilia* is almost exclusively tropical; *eubule* itself is most abundant in tropical America, where it probably originated. It may never have become completely adjusted to the seasons of a temperate zone. If this is true, then the southward migration can be regarded as an adaptation to avoid the necessity for overwintering. Some individuals do survive the winter, however, either as pupae or as imagines, but the scarcity of the species in early summer makes it probable that most of them either migrate or perish. This suggestion does not explain the frequent migrations observed in the tropics.[1]

Whatever the cause or purpose of migrating flights in *Catopsilia* may be, the notes confirm the conclusions of Williams ('26), that uni-directional flight is the active expression of an internal physiological or psychological state in the butterflies. This impels them to undertake self-contributory flight in a particular direction, which neither obstacles nor wind can prevent or even modify. This state may be produced by external conditions, but the flight itself is the result of volition or effort on the part of the butterflies. In this respect it is essentially similar to the migrating flight of birds, differing chiefly in its greater irregularity and in not being repeated by the same individuals. In its seasonal relations, the flight of *C. eubule* is similar to that of *Danaïs plexippus* L. (which likewise is a species of tropical origin), but differs in not being preceded by any concentration into large aggregations.

Anyone who observes this species in migration in the future can aid materially in solving its problems by making records of the pertinent facts in as great detail as possible. Such observations ought to be made in many localities and over a period of years. It is only through the co-operation of many observers that the mystery of the movements of countless butterflies can be explained, and it is to be hoped that intelligent efforts will be made to solve the problem of butterfly migration.

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[1] The late Walter Heape, in an exhaustive work on animal migration and related phenomena ('31), distinguishes between emigration, in which no return flight is made, and true migration, in which a return flight is always made and which recurs periodically. He would therefore class the present flight of *eubule* as an instance of emigration. Heape believes that overcrowding and shortage of food is the chief cause of emigration in butterflies, but it is not clear whether he refers to shortage of food plants for the larvae or of flowers for the adults. He recognizes sexual condition as a contributing factor, which weakens somewhat the distinction he makes between the two kinds of behavior.

SUMMARY

1. A southward migratory flight of *Catopsilia eubule* Linn. was observed in St. Louis County, Missouri, during September and early October, 1932.
2. Wind and obstacles did not change the direction of the movement. There was no mating, or formation of aggregations, and no other species accompanied them.
3. It is shown that although migration in this species may be related to environmental factors, or to internal and possible sexual conditions, yet the actual flight is due to voluntary efforts on the part of the butterflies.
4. No return flight has been observed; repopulation is effected by means of the gradual northward spread of stray individuals, or through the increase in numbers of the few that survive the winter in the north.

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THE GIANT TICKS OF THE MALAYAN RHINOCEROSES; WITH A NOTE ON *IXODES WALCKENAERII* Gervais

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In January, 1932, Major Arthur S. Vernay obtained, in Lower Perak, for the British Museum, one of the few remaining specimens of the Sunda Rhinoceros, *Rhinoceros sondaicus* Desmarest. At the suggestion of my friend and colleague, Harold J. Coolidge, Jr., he undertook to collect the ecto- and endoparasites of this animal. The helminths have been reported upon by my colleague, Dr. Jack H. Sandground (1933, Jl. of Parasitology, XIX, pp. 192-204). Of ectoparasites, only numerous ticks were found; but shortly after the animal was shot, a number of horse-flies (*Tabanus brunneus* Macquart) were observed biting through the thick hide.

More recently (June, 1933) Major Vernay commissioned Major Rawley to secure, if possible, another *R. sondaicus*. An animal believed to be of that species was located in Selangor; but, after being shot, it proved to be a Sumatran Rhinoceros, *Rhinoceros sumatrensis* Cuvier. Again the only ectoparasites met with were ticks; these were very few in number, eight in all being collected.

Since the ticks obtained from these two Rhinoceroses belong to two different species, one of which is as yet imperfectly known, some notes on these parasites may be of interest. I am much indebted to Major Vernay, Major Rawley, and Mr. Coolidge for the efforts they made in order to secure the specimens; and to Dr. P. H. Hodgkin, Entomologist, Institute for Medical Research, Kuala Lumpur, for preserving and mailing them.

Amblyomma crenatum Neumann

Amblyomma crenatum Neumann, 1899, Mém. Soc. Zool. France, XII, p. 214, fig. 52 (♀; off a Rhinoceros supposedly from the Cape of Good Hope); 1901, *Loc. cit.*, XIV, p. 297 (♀ ♂; Sumatra; no host); 1911, Das Tierreich, Lief 26, Acarina, Ixodidæ, p. 77, fig. 34 (♀ ♂). Robinson, 1926, Ticks, IV, *Amblyomma*, pp. 12, 21 and 75, figs. 32-33 (♀ ♂).

Amblyomma subluteum Neumann, 1899, Mém. Soc. Zool. France, XII, p. 263 (♂; two without locality, one of them supposedly off an African Rhinoceros).

? *Acarus elephantinus* Linnaeus, 1758, Syst. Nat., 10th Ed., I, p. 615 ("Habitat in India", no host); 1767, *Loc. cit.*, 12th Ed., I, pt. 2, p. 1022. Gervais, 1844, in Walckenaer, Hist. Nat. Ins. Aptères, II, p. 250. Neumann, 1911, Das Tierreich, Lief. 26, Acarina, Ixodidae, p. 126. A. C. Oudemans, 1926, Tijdschr. v. Entom., LXIX, Suppl., p. 95; 1929, *Loc. cit.*, LXXII, Suppl., p. 207 (with references to the older literature). Not of Schrank, 1776.

? *Ixodes elephantinus* Fabricius, 1805, Syst. Antl., p. 351.

? *Amblyomma elephantinum* C. L. Koch, 1844, Arch. f. Naturgesch., X, pt. 1, p. 230; 1847, Uebersicht des Arachnidensystems, IV, p. 19. Neumann, 1899, Mém. Soc. Zool. France, XII, p. 282.

Specimens Examined.—Twenty-four males and twelve females (two fully engorged), off *Rhinoceros sondaicus* Desmarest, shot four miles north of Teluk Anson and south of the Sungei Lampan, Lower Perak, Federated Malay States (Major Arthur S. Vernay and Dr. P. H. Hodgkin).

The true country of origin and correct host of *A. crenatum* are now definitely established with this material. The information available thus far was summarized by Robinson as follows: "*Amblyomma crenatum* is an African species and the only known host is the *Rhinoceros*. Neumann's earlier description of the female was based on a single specimen off *Rhinoceros*, Cape of Good Hope (Paris Mus.); his description of *Amb. subluteum* was based on two males, one of unknown origin, the other off Rhinoceros, Africa. The Berlin Museum collection contains 2 males and 2 females labelled as having been collected by Mösch, in Sumatra. It would seem improbable that this tick is to be found in two parts of the world so remote as Africa and Sumatra without its occurrence being recorded in intermediate parts, and the indication of origin of the Berlin specimens is probably erroneous." The present collection from Perak shows, on the contrary, that the locality "Sumatra" was correct, while there is no reliable evidence of this tick occurring in Africa. Neumann's specimens were most likely obtained from animals kept in captivity in Europe. Ticks have frequently been collected in large numbers in Africa from both the White and the Black Rhinoceros; but, so far as I know, *A. crenatum* was never found among them.[1]

A. crenatum is one of the largest ticks in existence. In our series of 24 males, the scutum of the largest measures 9 mm. in length (not including the capitulum) and 7.8 mm. in greatest width, and that of the smallest 5 mm. and 4.8 mm. respectively. It is noteworthy that the smaller the specimen, the more the scutum approaches the perfect orbicular shape. The 10 unengorged females are 8 to 9 mm. long (without the capitulum) and 7 to 8 mm. wide, the scutum proper being about the same size in the largest and smallest specimens. Two engorged females are enormous, reaching 21 and 22 mm. in length (without the capitulum), 20 mm. in greatest width, and 16 and 17 mm. in thickness. Capitulum and legs also are unusually long. The coloration is remarkably uniform in the series seen and agrees well with Robinson's account. The most remarkable feature is the absence of metallic spots in the male, while the female has three distinct coppery areas, one in each corner of the scutum, that of the apical corner the largest.

The holotypes of *A. crenatum* (♀ and of *A. subluteum* (♂) are at the Paris Museum.

I strongly suspect that Linnaeus based the following description of his *Acarus elephantinus* upon *A. crenatum:* "A. orbicularis depressus: macula baseos ovata. Habitat in India. Magnitudo seminis Lupini albi, depressus, lividus, margine crasso, subtus utrinque 3 sulcis. Macula baseos nigra, ovata, trifida." No host is mentioned and the name refers, not to the supposed host, as Houttuyn surmised, but to the unusual size ("elephantine"), this being one of the largest ticks known to Linnaeus. In answer to an inquiry concerning this tick, Professor Ivar Arwidsson writes me that the type is not in Linnaeus' collection at the Zoological Museum of the University of Uppsala. Perhaps it is kept at the Linnaean Society of London, a point which I have not yet been able to investigate.

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[1] I am unable to account for Neumann's including "Liberia" in the range of *A. crenatum* (1911, Das Tierreich, Lief. 26, p. 78), since there is no *Rhinoceros* in that country and he does not mention it in his earlier papers.

Amblyomma infestum infestum C. L. Koch

Amblyomma infestum C. L. Koch, 1844, Arch. f. Naturgesch., X, pt. 1, p. 226 (♀ ♂; no host; Bintang Island near Singapore); 1847, Uebersicht des Arachnidensystems, IV, p. 68, Pl. XII, figs. 41-42 (♀ ♂).

Amblyomma infestum infestum Schulze, 1932, Zeitschr. f. Parasitenk., IV, pt. 3, p. 468 (♀ ♂; after Koch's types).

Amblyomma testudinarium Robinson, 1926, Ticks, IV, *Amblyomma*, pp. 17, 23 and 253 (in part; not the description and figures).

Specimens Examined.—One male and three females (two partly engorged), off *Rhinoceros sumatrensis* Cuvier, shot on the Bernam River, Selangor, Federated Malay States (Major Rawley).

A. infestum is a much smaller tick than *A. crenatum*, with the capitulum and legs of normal length.

P. Schulze has recently claimed (1932, Zeitschr. f. Parasitenk., IV, pt. 3, p. 468) that the tick described and figured by Robinson (1926) as *A. testudinarium*, was not Koch's species of that name, but a new tick, which he calls *A. fallax* P. Schulze. Robinson's specimens came from Mouse-Deer (*Tragulus* sp.) at Biserat, Jalor, Federated Malay States. P. Schulze also attempts to separate *infestum* Koch and *testudinarium* Koch as distinct races of a species for which he uses the name *A. infestum* (because it comes before *testudinarium* on the same page of Koch's paper). Although I have seen no ticks agreeing with Robinson's descriptions and figures, I am inclined to believe that Schulze was correct in introducing *A. fallax* as a new species. At any rate, the male off Sumatran Rhinoceros ventrally lacks the small muscular scutes shown in Robinson's figure, while the peltæ run parallel with the festoons (in Robinson's figure they are oblique, slightly salient at the postero-internal angles. In the three females, the inner margin of the scapulæ is yellowish (not brown, as in Robinson's figure); and the median anterior area of the scutum is almost wholly yellowish (not dark, as in Robinson's figure), although I am not able to see that the yellow color forms two longitudinal stripes.

I am, however, by no means convinced that *infestum*, proper, and *testudinarium* are racially distinct. Obviously, Schulze's material was insufficient to show that they are geographically segregated. Of *infestum*, proper, he saw only Koch's types from Bintang Island near Singapore, one of the Rhio Archipelago, not 75 miles off the Northeast coast of Sumatra. Of *testudinarium*, he saw, in addition to Koch's type from "Java," 4 males and 4 females from Soekaranda, Sumatra.

The male of *infestum*, proper, is said to be smaller (length, including palpi, 6 mm.; width, 5 mm.), with much white enamel among the coarse punctures of the alloscutum. That of *testudinarium* would be larger (8 by 6 mm.), with reduced enamel among the coarse punctures. The single male from Selangor measures 7 mm. (with the palps) by 4.8 mm., and the enamel is quite extensive. According to Schulze, in the female of *infestum*, proper, the scutum measures 3 by 5 mm. and has the scapular stripe well-defined, dark brown. In that of *testudinarium* the scutum is larger (4 by 5 mm.), with the scapular stripe obsolete, pale brown. In all three females from Selangor the scutum measures 3 by 4.5 mm.; but the scapular stripes (on the anterior margin, between the scapulæ and the eyes) are dark brown and sharp in two specimens, very faint and pale in the third. While the Selangor specimens are undoubtedly typical *infestum*, the value of *testudinarium* as a distinct race remains a question.

In the foregoing bibliography, I have not included Neumann's references to *A. testudinarium* (1899; 1901; 1911), nor those of Krijgsman and Ponto (1931; 1932), since these authors may have confused more than one species under that name. Neumann (1901) synonymized with his *testudinarium*, *Ixodes auriscutellatus* Koningsberger (1900, Teysmannia, XI, pt. 1, p. 6) and later (1911) also *Amblyomma compactum* Neumann (1901, Mém. Soc. Zool. France, XIV, p. 296; ♀; Sumatra; no host). The standing of these two names remains open to discussion. Robinson's many locality and host records of *testudinarium* probably cover more than one species. In view of this fact the true distribution and range of hosts of *A. infestum* cannot be given.

Hyalomma (?) walckenaerii Gervais

Ixodes walckenaerii Gervais, 1842, Ann. Soc. Ent. France, XI, Bull. Séances, p. xlvii (off Rhinoceros; without description); 1844, in Walckenaer, Hist. Nat. Ins., Aptères, III, p. 246, Pl. XXXIV, fig. 11 (no sex; no locality, off a rhinoceros of unknown species). Neumann, 1911, Das Tierreich, Lief. 26, Acarina, Ixodidae, p. 133.

Amblyomma (?) *walckenaerii* Neumann, 1899, Mém. Soc. France, XII, p. 279.

Gervais' species is as yet unrecognized. Neumann merely suggested that it might have been an *Amblyomma*. The original description reads: "Corps roux-grenat, un peu plus pale en dessous, passant au roux-cannelle ainsi que les pattes qui sont allongées et fauves à leurs articulations; abdomen ridé en dessous; point de taches sur le dos; denticules des machoires médiocres; palpes un peu velus montrant un pore terminal à leur dernier article; ouverture génitale au niveau de la deuxième paire de pattes; hanches de la première paire bispinulées à leur bord postérieur; celles des autres simplement échancrées; stigmates dans une impression en fossette subréniforme à l'aisselle de chaque patte postérieure. Longueur du corps, 0.005 [m];

de la patte postérieure, 0.006 ½ [m]. Cette espèce, dont les hanches antérieures ressemblent à celles de l'Ixode de Savigny, a été prise sur un Rhinocéros dont nous ignorons le nom spécifique; nous l'avons dédiée à M. de Walckenaer, de qui nous tenons l'unique exemplaire que nous en avons observé." The rather crude figure represents the ventral side of what appears to be an unengorged female.

Surmising that Gervais' type might be preserved at the Paris Museum, I wrote to Mr. Marc André, who kindly informed me that none of Gervais' ticks are in their collections. Neumann evidently never saw them and I have been unable to trace whether or not they are lost.

I believe, however, that a study of the description and figure might help to recognize the species. Turning first to the *Amblyomma* known to occur on Rhinoceroses, *A. crenatum* is ruled out at once by the size, the hind legs of that species measuring 11 to 12 mm. in length. On the other hand, none of the smaller Rhinoceros ticks could be described as having the body "roux-grenat", all being distinctly spotted dorsally. The statement about the color, and even more so the comparison of the coxæ I with those of *Ixodes savignyi* Gervais, induce me to regard *Ixodes walckenaerii* as based in all probability upon a female *Hyalomma*.[1] Ticks of that genus have been found repeatedly on the African Black Rhinoceros; and P. Schulze bases his *Hyalomma planum* (1919, Sitzungsber. Ges. Naturf. Fr. Berlin, pp. 195 and 196; ♂ ♀; Tanganyika Territory) on ticks taken from this host. Might not *H. planum* and *H. walckenaerii* be one and the same species?

[1] *Ixodes savignyi* was based upon the common cattle *Hyalomma* of Egypt. According to P. Schulze (1930, Zeitschr. f. Parasitenk., III, pt. 1, p. 28). *Hyalomma-savignyi* (Gervais) is the correct name of the cattle tick which thus far has been called *Hyalomma aegyptium* (Linnaeus.

COURTING AND MATING PERFORMANCES OF AN ASILID FLY *(HETEROPOGON LAUTUS)*

On September 13, 1932, in a mesquite pasture near Spur, Texas, the small robber-fly, *Heteropogon lautus* Loew, was very abundant, numbers perching on the tips of dead twigs of the mesquite five or six feet from the ground and on the barbs of a wire fence enclosing the pasture. They betrayed interest in passing objects by quick movements of their heads, but were not wary and could easily be captured by hand. Several were seen feeding on small winged formicids. But what attracted our attention particularly (Mr. W. C. O'Dowd of the Texas Agricultural Experiment Station was with me and together we watched the phenomenon) were their peculiar actions which observation proved to be courtship and mating. Hovering in front of the female at a distance of about an inch, the male would poise, oscillating somewhat from side to side and waving his front tarsi, which are clothed with appressed white hairs, toward the female. He might continue in this position for a period of thirty seconds or more. Often the female appeared to ignore his presence; at other times she watched him eagerly, waving her front tarsi in return and spasmodically half-raising and lowering her wings. The male would then fly over, turn in midair and alight in back of the female, coition then taking place. At other times males were seen to alight in back of the females and press their mystacal bristles against the spines of the cerci surmounting the ovipositor. At such times, the female would half-raise and lower her wings as described before. Frequently the male would then spring to his hovering position in front of the female and the tarsi waving would begin again. In one instance, an additional male was noted hovering in front of a pair in copulation.

STANLEY W. BROMLEY.

NOTES ON THE FULGORIDAE WITH SOME NEW SPECIES.

BY E. D. BALL,

University, Tucson, Arizona.

The large and showy representatives of the sub family *Fulgorinæ* are largely tropical, only a few of the smaller and more somber forms appearing along the southern boundary of the United States. Owing to the fragmentary character of our knowledge of the tropical forms it has been difficult to correctly place even the few we have. In a recent survey the following additions and corrections appeared to be warranted.

Calyptoproctus marmoratus Spin. 1839 (=*Crepusia glauca* Metc. 1923). Spinola and Stal describe *Calyptroproctus* as having the *fifth* dorsal segment of the *female* abdomen as long as the three preceding segments and *tricarinate.* Metcalf, in his key, gives *ninth* abdominal segment elongate *quinquecarinate* for *Calyptroproctus* Spin. and *ninth* abdominal segment not elongate, not quinquecarinate for *Crepusia* Stal. (italics mine). He must have misinterpreted the description and overlooked the fact that this character is only present in the females and examined only males of his *Crepusia glauca,* of which he reported 12 males and only one female. The females of this Arizona species have the elongate tricarinate segment and answer in every way to the description of *marmoratus* and to Dozier's figure of the Mississippi example.

This species is now definitely known from Mississippi, Brownsville, Texas, and from a number of places in the southern half of Arizona.

Crepusia is apparently one of the many genera proposed by Stal in his Hemiptera Africana keys that were never described or to which no species was referred. The characters given in his "Key to the American Fulgorid Genera" are inconsistent with those given previously. It seems best therefore to fix *glauca* Metc. as the type of *Crepusia* Stal. which will make it a synonym of *Calyptoproctus* if *marmorata* is correctly referred to *Calyptoproctus* as represented by *elegans* L & S its type.

Poblicia fuliginosa Oliv (1791) (=*missella* Stal (1864) (=*thanatophana* Kirk (1907). This large dark species has a line on the vertex, the transverse veinlets towards the apex of the elytra as well as scattered small spots, creamy white. It varies in shades of brown or black but the posterior two-thirds of the abdomen above is always scarlet red with four lines of black dots, which agrees with the various descriptions. It is found from North Carolina, Ohio, Kansas and Southern Arizona, south to Georgia, Texas and Mexico.

Cyrpoptus vanduzeei Ball n. sp.

Similar to *nebeculosus* but smaller and darker. The smallest darkest species in the genus. Dark brown, vertex creamy, with a broad, medium black stripe. Length (with elytra) 10 mm.

Form of *metcalfi*, smaller with a relatively shorter, thinner, more depressed and foliaceous vertex. Vertex evenly rounding, little if any longer than pronotum, half longer on middle than against eyes. Pronotum with a definite median carina and traces of lateral ones behind the eyes. Mesonotum with three broad carinae indicated. Elytra with the lateral margins but slightly sinuated, the apical margin scarcely oblique.

Color dark brown mottled, the vertex and apex of mesonotum creamy with a broad black median stripe throughout. Elytra with the basal two-thirds dark, the apical third subhyaline, heavily brown flecked in more or less concentric rows. Underwing hyaline with smoky veins, the basal third pale yellow, the angle of the folded area with a small dark cloud, abdomen pale yellow above. Face soiled tawny, the lower part of clypus and coxae dark brown; venter finely irrorate.

Holotype ♀, one ♀ and two male paratypes Baboquivari

Mountains, April 11, 1932. Allotype ♂ Santa Cruz River April 22, 1932, and one paratype ♀ Tucson, April 27, 1930. All taken in Arizona by the writer from bunches of mesquite grass (*Muhlenbergia porteri*) growing under spiny shrubs. Named in honor of E. P. Van Duzee whose foundation work on the Fulgoridae of Temperate North America will long endure.

Cyrpoptus metcalfi Ball n. sp.

Smaller and narrower than *belfragei*, much paler. Pale testaceous, the subhyaline elytra allowing the orange and black of the wings to show through. Length (with elytra) 12-14 mm.; expanse 26 mm.

Vertex roundingly produced, the margin thick and the surface depressed, longer than the pronotum, twice as long on middle as against eyes, front as seen from side strongly concave, the upper part and vertex compressed foliaceous, little if any thicker than the margin.

Color, uniform pale cinnamon with a tawny tinge, no definite spots or markings, face and below pale creamy, occasionally finely irrorate with scarlet above. Vertex creamy, base of pronotum washed with brown omitting a median carina. Elytra subhyaline, under wings hyaline with orange nervures, the basal third reddish orange, the apex of the fold black, abdomen yellow above.

Holotype ♀, allotype ♂ and 14 paratypes, August 25, 1929, Yuma, Arizona. These were taken by the writer sweeping on arrowweed (*Pluchea sericea*) and mesquite in the Colorado River bottom. Named in honor of Dr. Z. P. Metcalf who has recently published upon the Fulgoridae of the Eastern United States. From *nebeculosus* this species can be separated by its smaller, narrower form, lack of dark spotting and the convex ventral surface of the male plates while in that species they are furrowed. It is smaller and has a longer head than *suavis*, from Mexico.

Ormenis quanta Ball n. sp.

Form and size of *pallidacosta* nearly, broader, with angularly produced front. Green. Length ♀ 14 mm. ♂ 12 mm. Width of ♀ elytra at apex 8 mm.

Front narrow, extending forward and downwards three-fourths its length, then abruptly retreating in line with the clypeus forming a right or slightly obtuse angle, lateral margins foliaceous and broadening to the antennae, a median carina extending to the angle, mesonotum large, convex, polished, faintly tricarinate. Elytra as in *pallidacosta* expanding apically where they are truncate with the inner angle acute and the outer (costal) very slightly rounding. Two rows of transverse veinlets slightly more definite in *pallidacosta.* Color pale green, probably deep green in life, with the front and clypeus paler, shading to straw.

Holotype ♀ allotype ♂ and one paratype Iguala Gr. and three paratype males Cuernavaca, all taken in Mexico in September 1898 by O. W. Barrett. This species would run to the genus *Lechara* Stal in Melechar's key on the angled front, but this group is from the Celebes and quite distinct in other structures. This species seems to be a typical *Ormenis,* near *pallidacosta* and is so placed. It is easily separated by the green, rather than the blue-green color of that species and by the angled front.

Ormenis yumana Ball n. sp.

Small, powdery green or slaty white, with a smoky tip, resembling *leucophaea* in the slender form but with two definite transverse lines. Length ♀ 8 mm. ♂ 8 mm., width of elytra 3 mm.

Front broader than long, the margins rounding, disc flat with a very feeble median carina and traces of one on the vertex margin; elytra more than twice longer than wide, the margins parallel, the apex slightly obliquely truncate with the angles equally rounding. Two distinct lines of transverse nervures, with only about 10 full length cells between them instead of very indistinct with about 14 cells in *saucia* and only one line in *leucophaea.*

Color, pale green becoming smoky posteriorly with scarcely a trace of blue-green as in *relicta,* or almost entirely slaty with the nervures green, or becoming white on the darker apex. The costal margin is paler becoming almost white in the slaty examples.

Holotype ♀, allotype ♂, November 2, 1929, a pair of paratypes August 25, 1929, two males March 16, 1930, two pairs March 29, 1932, two females June 9, 1931, all from Yuma, Arizona, and one female, Calixico, California, June 10, 1931. All collected by the writer. The specimens taken in March were all slaty. Those taken in the summer, green.

Acanalonia servillei Spinola (=*Acanalonia latifrons* Walk)

There is certainly but a single large blunt-headed species of this genus occurring in the United States. The definite median carinae from vertex to mesonotum, renders it strikingly distinct in the group. *A. servillei* was described from Philadelphia, while *latifrons* was from New Orleans. The writer has collected this species abundantly on the grounds of Swarthmore College near Philadelphia, and again in still greater abundance in Florida. He has a large number of examples from Hayti and has examined material from Pennsylvania south to South America in different collections and feels certain that there is but one species involved.

Acanalonia saltonia Ball n. sp.

Form of *clypeata* nearly, much larger, with the front rather than the clypeus inflated. Long, narrow, pale green with an obtusely conical head. Length ♂ 9 mm., width of elytra 4 mm.

Vertex resembling *clypeata*, more definitely angled than in *virescens*, flat on disc. Elytra long, narrow, parallel margined and almost truncate at apex, much longer than in *virescens*. Face sloping, the front inclined to be inflated, the clypeus broader above than in *clypeata* and less inflated. Pale powdery green in life, fading to pale straw.

Holotype ♂ and two paratype males taken by the writer at Imperial, California, June 18, 1909.

Acanalonia virescens Stal. A male that agrees with Mexican material of this species was taken by the writer at Marco, Florida, May 15, 1928.

Acanalonia mollicula V. D. The writer has collected this blue-green species in Southwestern Utah, Southeastern Nevada and Northwestern Arizona, in addition to Mojave and Jacumba, California.

Acanalonia concinnula Fowl. The writer took a male of this species at Venice, Florida, July 27, 1927. This example agrees with China's recent drawings and has the brown stripe on the suture. It appears to differ from *fasciata* in a number of characters.

Acanalonia planata Ball n. sp.

Resembling *concinnula* but with a longer, flatter carinate vertex and almost semicircular elytra. Pale green. Length ♂ 6 mm.; width of elytra 3 mm.

Vertex broad, flat, horizontal, longer than pronotum, joining the front in a right angle, the margin with a definite carina, anterior margin rounding, posterior margin concave, parallel. Front upright, the lateral margins parallel, clypeus sloping back. Elytra hemispherical entirely, rather finely, reticulate, longitudinal nervures with few branches.

Holotype ♂ and a paratype ♂, Brownsville, Texas, July. This is a larger species with a much longer and more produced head than *laticosta* from the same region.

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